The Model Research on Mode Choice of Enterprise Cooperative Innovation

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Abstract: There is a major impact on the market due to the arrangements of different enterprises of cooperation and innovation of the business model innovation performance and competitive position. In the process of innovation, cooperation should consider various factors in the selection of an appropriate model and innovation. In fact, a particular enterprise does not only use the innovative approach, which is often a combination of various methods. For example, certain technologies through market transactions, some concessions to technology, access from cooperation with other enterprises in the form of technical union, or non-proprietary cooperation, and other key technologies through internal development achieved independently, or through the cooperation and innovation of property rights. During the process of innovation, enterprises need to focus on a problem which should be solved is how to establish different models of innovation (organizing style) for model analysis, which is based on different technical innovation.

On study of enterprise cooperative innovation, theories field had studied the enterprise cooperative innovation mode of game's, choice factors' and successful factors' analysis. The paper will apply rise decision method establish the choice model of enterprise cooperative innovation for offering basis enterprise cooperative innovation's decision in the innovative types, the mode of enterprise cooperative innovation.

Key word: Cooperative innovation, Enterprise, Model analysis ,Model selection

1 Introduction

Schumpeter took the social, cultural, psychological and system factors into the discussion about entrepreneurs innovation, which makes Schumpeter's innovation theory with obvious "New History schools" and the school system colors. Schumpeter's theoretical system involving a wide range of topics, including not only his own innovation theory but also the theory of profits and interest theory, the theory of economic growth, the theory of economic cycle and the social transition theory based on the innovation theory. On this basis, this paper attempts to explore theoretical system of the technological innovation comprehensively.

2 The division of type of enterprise cooperative and innovation based on the organizational integration and interdependence

Different organizational model reflects the internalization degree of organization and the interdependence of different degree among organization. For example, level organization represents the organization which is completely internalization，corresponding to the market relationship. Every enterprise participate in the market independently，transaction on the mutual interested issues，there is no interdependence between organizations. The organization of cooperative innovation exist the two extremes above. We will divide the innovation type of enterprises in accordance with the organizational integration and interdependence. Here it only discusses the cooperation in the research and development stage of enterprises.

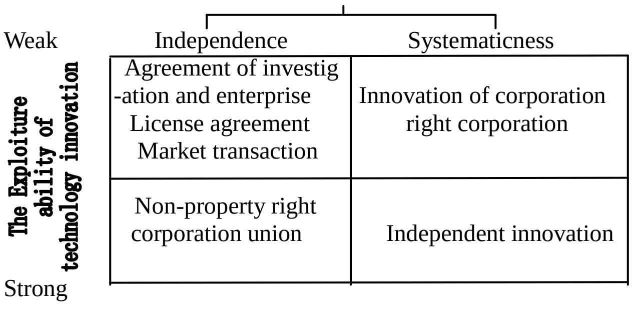
⑴Technology Merger & Acquisition. It obtains their technology through merger. Cisco, Microsoft regularly access technology and eliminate potential competitors through merger and acquisition. As technology merger and acquisition is essentially technical cooperation oriented, we also consider it as a type of enterprise's cooperative innovation.

⑵Joint Ventures or Research Corporation. Several enterprises joint resources, experts and skills to establish a new research and development enterprise, and share profits and investment costs in accordance with their respective equity investment. This type appears in high-tech areas or technology-intensive industries areas.

⑶Minority Equity Investment. Big enterprise invests the equity investment to small high-tech enterprise, which can be seen as a technical cooperation when the equity investment has clear technical intention.

⑷R&D Consortia. The organization of collaborative research that is formed by different enterprises, universities, research institutions and government integrates basic research, applied research and technology development. The aim is enable participants to maintain leadership position or close to international competitors in the particular industry, such as the SEMATECH and MCC in the USA, the VLSI in Japan, the ESPRIT in EU and so on.

⑸Joint R&D. Enterprises or enterprises and universities, research institutions share resources together, research and develop jointly to acquire specific technologies. This type is typical in Japan, the National University receives researchers and research funding from private enterprises, then universities and researchers of enterprises



Independence	Systematicness
Agreement of investig-ation and enterprise License agreement Market transaction	Innovation of corporation right corporation
Non-property right corporation union	Independent innovation

Fig.1 the relationship between innovative models and cooperative innovation models

are equal to do collaborative research of the same project at the University in order to promote outstanding scientific achievements.

(6)Networks. Most enterprises establish a loose cooperation. Technical knowledge and information could be shared and transmitted freely in the organization.

⑺R&D Contract. Usually big and small enterprises or universities, research institutions sign contracts. Big enterprise gives capital and small enterprise completes specific research projects.

⑻Technology Exchange Agreements. It is including technology sharing agreements and cross-licensing agreements.

⑼Licensing Agreements. The enterprises, universities and research institutions which own specific technology realize technical cooperation and transfer through distributing patents and licenses to other enterprises. Japan has adopted advanced semiconductor technology with this way in 1970s.

3 The model of types of innovative business cooperation and innovation

Innovative mode will affect types of arrangements for the enterprise cooperation and innovation. Innovative types can be divided into independent innovation and systematic innovation. Some independent technological innovation has its own technology development track，which can not rely on other areas of technological innovation and can achieve technological breakthroughs independently[1]. For example, by improving automobile engine turbocharger power, we do not need to re-design a car engine and also not need to change other parts of the vehicle. However, some systemic innovation, which is only relevant to a number of technical innovations in various fields together, will be able to demonstrate the charm of systemic innovation. For instance, fast imaging technology innovations will need new technology in close cooperation with the new camera equipment; agile production technology will be required to achieve production design, vendor management, and the corresponding information network of cooperation and innovation.

It is crucial for choosing a suitable model of cooperative innovation to differentiate systematic innovation and independence[2]. When independent innovation is relatively simple, non-proprietary forms of cooperation are sometimes even a relatively more efficient market transaction; for innovation of the system, this close cooperation approach of the property rights will show many advantages. If the ability to be independent or even as circumstances is permitted, enterprises would complete the process of innovation by themselves. Therefore, enterprises will base on technical innovation and innovative types of enterprise to classify the innovation patterns as shown in Fig1[3]: The lucid relationship between Independent innovation and technological innovation and uncertainties is seldom involved in the field of integrated multi-disciplinary. The innovative projects are easily divided into modules, so partners can take an independent, non-proprietary decentralized cooperation alliance[4]. If the enterprise's technological innovation capability is weak, it can be entrusted to carry out research and development in other enterprises, or to access to the technology through licensing agreements or even directly to buy technology in the market. For simple independent innovation, the approach non-proprietary may avoid the higher cost of property rights cooperation and additional expertise investment for setting up union with greater flexibility.

In contrast, systemic innovation requires a high degree of interrelated subsystems. Participants need a high level of sharing of knowledge assets and can coordinate their activities in the entire system of innovation. Because of the interdependence between strong enterprises moment and the exchange of mainly empirical knowledge, enterprises should take a closer cooperation of property rights. If the enterprise's ability to make technological innovations has enough depth and breadth, it will be the best choice to innovate independently[5]. It would be better for Standardized management of the inter-organizational level to organize a complicated system, avoid possible conflicts among the partners and coordinate difficulties.

In addition to the two points discussed above, it is also necessary to consider other factors in a model of cooperation and innovation choice. In general, property rights agreement is adaptable to the intensive research of enterprises in innovative activities because it provides a relaxed environment which is propitious for academic researchers to discuss the issue and exchange. Conversely, if enterprises expect to learn empirical knowledge, technology transfer or other with the intent of the production technology through cooperation, property rights cooperation will be a good choice. In addition, the choice of mode of cooperation taken into account, which is located in the technical characteristics of property cooperation, is suitable for the relatively mature industrial sector, and is not suitable for high-tech innovation in areas of property rights agreement[6].

4 Analysis of pattern choice of innovation models for enterprise

When the core market opportunities to realize their own capacity can not meet the demand, it can be achieved through non-proprietary cooperative alliance to meet the demands of market opportunities, or by the cooperation of property rights and innovation[7]. The analysis in this section will develop market opportunities through non-core property business cooperation with the alliance to choose the most innovative property cooperation which is the best mode of decision-making. This section will not consider the value of research and development options.

4.1. Description for the basic model of enterprises cooperation and innovation

Yet generally speaking, if a core enterprise A has identified that certain research and development activities show promise, but its own research and development activities in a certain part are lack of capacity, in order to make up its' own deficiency, core business A may cooperate with the enterprise B who possesses this capacity to carry out research and development through innovation and cooperation of property rights. Union and non-property rights through cooperation can also have this ability to set up virtual R & D activities with enterprise B who has this capacity. If the core enterprise A adopts the cooperation of property rights and innovations to develop innovative strategies for achieving the opportunities, then we may suppose that costs for cooperation of property rights should be C_{B1} [8]. However, there is the possible failure of cooperation and property rights, such as cultural differences which may lead to the failure. A core business is expected to assume that the probability of successful cooperation property rights should be P_{B1} and the corresponding failure probability should be $1- P_{B1}$. The time of the successful cooperation required carrying out research and development as the beginning should be T_{B1}. Although the cooperation of property rights will be successful, it does not mean that success will conduct research and development activities because R & D is a high-risk and high-yield activity, which is why h (x) to risk (hazard rate). It will show that the core business A inputs x (not including the cost of property rights cooperation) to achieve the probability of successful development. If h (x) is the second consecutive differentiable function and meet the condition of $h'(x)>0$, $h''(x)<0$, $h(0)=0$, $\lim_{x\to\infty} h'(x)=0$. Assuming $h(x)=1-e^{-\lambda x}$, $0<\lambda<1$, λ is the contribution rate for the input costs of innovation, and meet these conditions above. We may suppose that the time required for the product from *R & D* to the market is TB_2. If innovation will succeed, core business A will gain profit N_t each year, assuming that the life cycle for the market opportunities is *T* then the deadline of proceeds will be $T-TB_1-TB_2$ and free -risk rate as r, so we may suppose the profit of innovation success as the *N (x)*. Therefore, if innovation is failure, it will yield 0.

If core enterprise *A* appreciates to realize market opportunities by the adoption of non-proprietary cooperation with enterprise *B*, we know that there are transaction costs for the same formation of a cooperative enterprise, such as the cost of negotiations with *B*, assuming that the transaction cost of setting up cooperative enterprises is C_{V1}. Similarly, there is a risk of failure (not including the risk of technical projects) for the formation of a cooperative enterprise, such as the risk of breakup resulting from the cultural communication, so the probability of successful cooperation in the formation of enterprises is P_{V1}, and the probability of failure is $1- P_{V1}$. The time for the core enterprises to set up cooperative enterprises is T_{V1}. After the successful cooperation of enterprises engaged in research and development activities in the beginning, assuming the successful development of the same probability as h (y).It is assumed that the period from R & D to introduction of the product on the market is T_{V2}, If innovation is successful, each year of the proceeds of the cooperative enterprise is N_t, and the presumption is that the life cycle for the market opportunities is T, so the period of gaining profit is $T\text{-}TV_1\text{-}TV_2$ years. If the interest at risk is R, then the proceeds of successful innovation will be *N (y)*; Therefore, if innovation is failure, it will yield 0. *A* decision tree for the core enterprise will be shown on Figure 2[9].

4.2 Solving business model of cooperation and innovation

(1) The expected net income by cooperation and innovation of property rights[10]

The discounted value of the future earnings can be calculated using traditional *NPV* when core business A is developed successfully. Through cooperation of property rights for the success of innovative technologies, the discounted value of the future earnings is

$$V_B = \sum_{t=T_{B1}+T_{B2}}^{T} \frac{N_t}{(1+r)^t} \tag{1}$$

Well, the expectations of a net gain in the core business A is

$$N(x)= P_{B1}\{ h(x) \sum_{t=T_{B1}+T_{B2}}^{T} \frac{N_t}{(1+r)^t} - \frac{x}{(1+r)^{T_{B1}}} \}- C_{B1} \tag{2}$$

The first-order condition of the formula (2-2) is

$$x^*= \frac{1}{\lambda}\{\ln (1+r)^{T_{B1}} + \ln[\lambda \sum_{t=T_{B1}+T_{B2}}^{T} \frac{N_t}{(1+r)^t}]\} \tag{3}$$

To type the formula (3) into the formula (2), it can be calculated that the ultimate expected net income to achieve market opportunities by cooperation and innovation of property rights for core enterprise *A* is *H (x*)*[11].

(2) The expectations of a net income in property rights cooperation organized by the non-virtual enterprise[12]

If the core businesses can operate virtual enterprise successfully, it will pay the reward for *B*, and the method of payment for a fixed remuneration *(G)* + benefits payment (*bV (y)*) (There is no incentive to consider the core business), and b rewards them for efficiency coefficient, $0 \leq b \leq 1$, *V (y)*

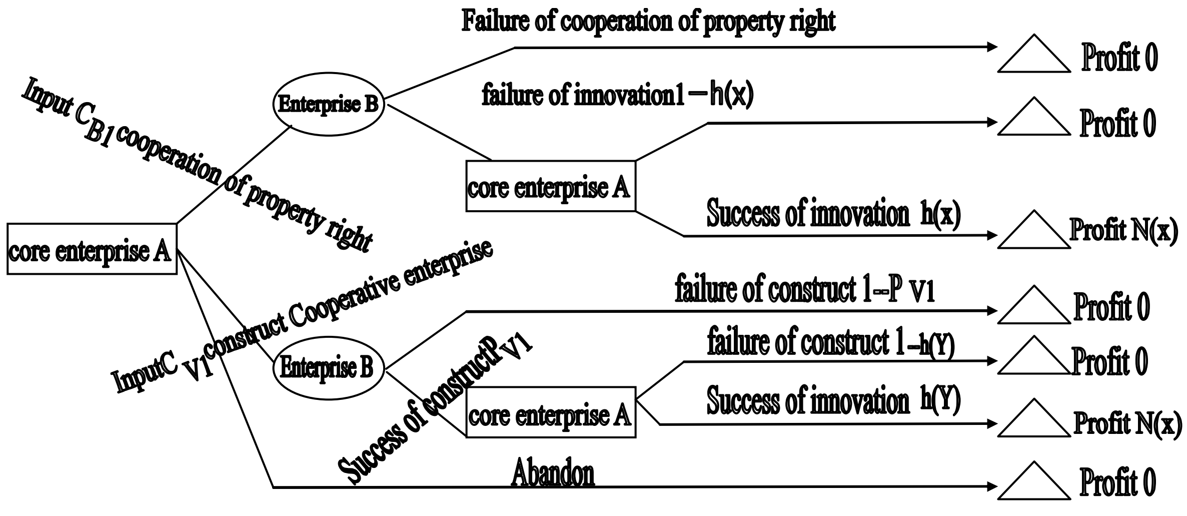

Failure of cooperation of property right
Profit 0
Input C B1 cooperation of property right
Enterprise B
failure of innovation1 — h(x)
Profit 0
core enterprise A
core enterprise A
Success of innovation h(x)
Profit N(x)
InputC V1 construct Cooperative enterprise
failure of construct 1—P V1
Profit 0
Enterprise B
Success of constructP V1
failure of construct 1-h(Y)
Profit 0
core enterprise A
Success of innovation h(Y)
Profit N(x)
Abandon
Profit 0

Fig .2 the decision tree model of the core business

for innovation proceeds, y as innovation costs. That cooperative enterprise net will be

$$V(y)=(1-e^{-\lambda y})\sum_{t=T_{v1}+T_{v2}}^{T}\frac{N_t}{(1+r)^t}-\frac{y}{(1+r)^{T_{v1}}} \qquad (4)$$

Then, the net income for enterprise B paid by the core business A will be

V(x)=

$$b\{(1-e^{-\lambda y})\sum_{t=T_{v1}+T_{v2}}^{T}\frac{N_t}{(1+r)^t}-\frac{y}{(1+r)^{T_{v1}}}\}+\frac{G}{(1+r)^T} \qquad (5)$$

Well, the expectations of a net income for the core enterprise A

N(y)=

$$P_{v1}\{(1-b)\{(1-e^{-\lambda y})\sum_{t=T_{v1}+T_{v2}}^{T}\frac{N_t}{(1+r)^t}-\frac{y}{(1+r)^{T_{v1}}}\}+\frac{G}{(1+r)^T}\}-G_{V1} \qquad (6)$$

The first-order condition of the formula (6) is

$$y^{*}=\frac{1}{\lambda}\{ln(1+r)^{T_{v1}}+ln[\lambda\sum_{t=T_{v1}+T_{v2}}^{T}\frac{N_t}{(1+r)^t}]\} \qquad (7)$$

To type the formula (3) into the formula (2), it can be calculated that the ultimate expected net income by cooperation and innovation of property rights for core enterprise *A* is *N (y*)*. According to the above description, the core enterprises A make the decisions[13]: ① If the core business achieves the optimal values in investment for *R & D* funds, rational core enterprise *A* may choose the size and strategic mode by comparing *N(x*)*, *N(y*)* and *0* value. If *N(x*)> N(y*)> 0*, core business A will then choose cooperation and innovation to achieve through the equity market opportunities; If *N(y*) >N(x*)>0*, core business *A* will then cooperate with the coalition formed a cooperative enterprise *B* through non- property rights to achieve market opportunities; If *0>N (y*)>N(x*)*, core enterprise *A* should abandon this market opportunities. ②If invested amount of core enterprises A is less than optimal values, rational core business *A* may compare the size of the formula(2) with that of (6) to achieve market opportunities by choosing the strategic mode[14].

According to the formula (2) and (6), we may also find that core business *A*, whether innovations through property ownership or through non-cooperation to achieve the alliance formed cooperative enterprise market opportunities, the net value is increased with its life cycle of market opportunities. When the market opportunities meet the shorter life cycle, core business *A* will achieve more profits from the establishment of a cooperative enterprise than from the cooperation and innovation of property rights. However, when market opportunities lives are long enough, core business *A* will achieve more profits from the cooperation and innovation of property rights than from the establishment of a cooperative enterprise[15]. This explains why, in theenvironment with increasingly fierce competition where the life cycle of market opportunities is becoming shorter and shorter, it would be better for enterprise to choose cooperation and innovation of non-proprietary option to achieve market opportunities, named as pace creating

efficiency. Fig 3 is the comparison for core business *A* to achieve the expected net incomes by cooperation of property rights[16]. Fig 4 shows how the expected net incomes will be fluctuated according to changes in market opportunities due to the adoption of non-proprietary cooperation by setting up cooperative enterprise[17].

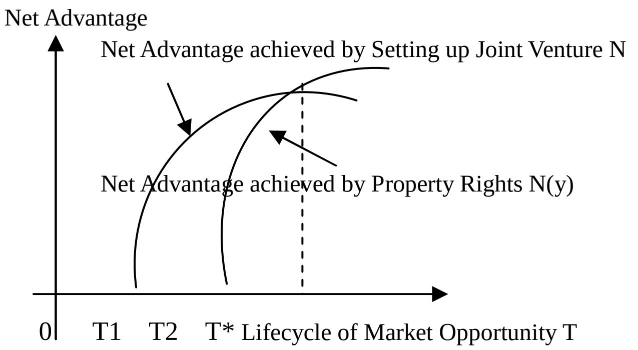


Fig 3 Figure for comparison of Net Advantage of Core Enterprise A

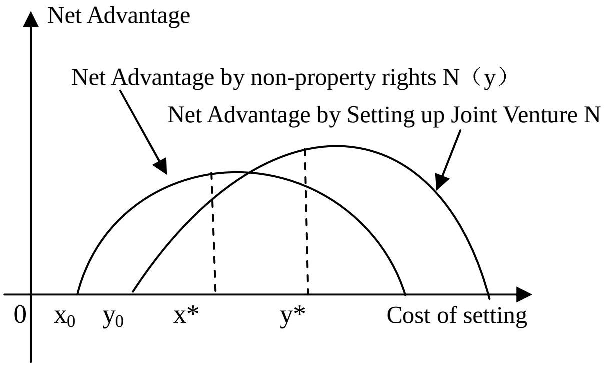


Fig4 Figure for Alterations in anticipation of Net Advantage of Core Enterprise A

5 The analysis of examples

The cash flow of successful development as shown in Tab 1[18]. It can be presumed that the life cycle of the market opportunities is six years and the risk rate r=10%. If the core enterprise *A* achieves market opportunities through cooperation and innovation of property rights, its merger cost will be five million Yuan, and the rate f success merger is P_{B1}=0. 85. After the success of innovative approaches for cooperation property, the use of innovative cost will be *x*=2 million Yuan and the cost of the property cooperation will be T_{B1}=1year, and time for *R & D* will be T_{B2}=1year, and contribution coefficient of innovation cost will be λ = 0.01. if *A* core business achieves market opportunities through the formation of cooperative enterprise, its establishing cost is C_{V1}=100,000 , and the rate of success is p_{V1} =0 . 8 , and the time for construction is T_{V1} =3months , and the time for innovation is T_{V21}=9months, and the cost of innovation is *Y*=2,000,000. After the innovation of the success, the fixed remuneration should pay to the enterprises[19].

Which is *G*=2,500,000 Yuan and Partition coefficient is b=0.2.

According to the formula (1), it can be calculated that V_B =14,458,400 Yuan. According to the formula (2), it can be calculated that anticipation of Net advantage of core enterprise *A* is *N* (200) =4,080,960Yuan. According to the formula (4), it can be calculated that *V(y)* =15,123,700Yuan. According to the formula (5), it can be calculated that anticipation income of enterprise B is 3,347,180 Yuan. According to the formula (6), it can be calculated that anticipation Net income of core enterprise *A* is *N* (200) =8,450,200 Yuan. Therefore, core enterprise *A* will decide to achieve the *R&D* opportunity by setting up the joint venture[20].

If core enterprise investing in the *R & D* funds can reach the optimal values , it can be calculated that *x**=2,911,000 Yuan according to the formula (3); it also can be calculated that optimal values of core enterprise A is *N*(299. 1)=4,302,100 Yuan according to the formula (3). Then, According to the formula (7) , it can be calculated that y*=305. 53, then substitute to the formula (6) , it can be calculated that *N*(305. 53)=8,758,000 Yuan[21]。Actually, core enterprise A by increasing the cost of innovation to increase the probability of successful innovation, as a consequence that the core business is expected to increase revenue expectations.

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Tab.1 Flow of R&D Cash **(Unit: Ten Thousand Yuan)**

Strategy Model	Fixed number of years	0	1	2	3	4	5	6
Cooperation of property rights	Net of Capital Input	500	200					
	Flow of cash			350	450	500	450	350
Build joint Venture	Net of capita input	10+200						
	Flow of cash		350	450	600	500	450	350

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